Claims

1. A radar antenna assembly for use as a transmitter, receiver or transceiver comprising:

a tubular casing having a radar-reflective inner surface and having a first end, a second end and a longitudinal axis;

a radar-reflective reflector closing said first end;

an aperture disposed at said second end;

at least one elongate antenna element extending substantially parallel to said longitudinal axis from said reflector towards said second end; and

dielectric material substantially filling the interior volume of said tubular casing.

2. A radar antenna assembly as claimed in Claim 1, further including focussing means at said second end.

3. A radar antenna assembly as claimed in Claim 2, wherein said focussing means includes a plurality of concentric slit ring apertures located at said second end.

4. A radar antenna assembly as claimed in ~~Claim 2 or~~ Claim 3, wherein said focussing means includes at least one dielectric lens element located at said second end.

5. A radar antenna assembly as claimed in Claim 4, wherein said dielectric lens element comprises a planar lens element.

6. A radar antenna assembly as claimed in Claim 4, wherein said dielectric lens element comprises a plano-concave lens element.

7. A radar antenna assembly as claimed in Claim 4, wherein said dielectric lens element comprises a plano-convex lens element.

8. A radar antenna assembly as claimed in any preceding Claim, wherein said tubular casing has an inner diameter D_T of which is an integer multiple of the diameter D_A of said at least one antenna element.

9. A radar antenna assembly as claimed in any preceding Claim, wherein said tubular casing has an interior length L_T which is an integer multiple of the length L_A of said at least one antenna element.

10. A radar antenna assembly as claimed in any preceding Claim, wherein an interior surface of said tubular casing comprises an antenna cathode and said elongate antenna element comprises an antenna anode.

11. A radar antenna assembly as claimed in Claim 10, wherein said elongate antenna element extends along said longitudinal axis.

12. A radar antenna assembly as claimed in any one of Claims 1 to 9, including at least two of said elongate antenna elements, at least one of which comprises an antenna cathode and at least one of which comprises an antenna anode.

13. A radar antenna assembly as claimed in Claim 12, wherein said elongate antenna elements are disposed symmetrically about the longitudinal axis of the tubular casing.

14. A radar antenna assembly as claimed in Claim 13, wherein said elongate antenna elements have substantially equal lengths and diameters.

15. A radar antenna assembly as claimed in Claim 14, wherein the interior diameter D_T of the tubular casing is an integer multiple of the diameter D_A of said elongate antenna elements and of the spacing between adjacent pairs of said elongate antenna elements.

16. A radar antenna assembly as claimed in any preceding Claim, wherein said dielectric material is a liquid.

17. A radar antenna assembly as claimed in any preceding Claim, wherein said dielectric material is a solid.

18. A radar antenna assembly as claimed in any preceding Claim, wherein said dielectric material is a powdered solid packed into the interior of said tubular casing.

19. A radar antenna assembly comprising a closed chamber adapted to contain a sample of material, said chamber including four substantially triangular side

walls together defining an open-based pyramidal structure, said assembly including transmitter antenna elements disposed on interior surfaces of a first opposed pair of said triangular side walls and receiver antenna elements disposed on interior surfaces of a second opposed pair of said triangular side walls.

20. A radar antenna assembly as claimed in Claim 19, wherein said antenna elements comprise bowtie dipole antennas with respective cathode and anode elements disposed on said opposed pairs of said triangular side walls.

21. A radar antenna apparatus as claimed in Claim 19 or Claim 20, wherein the base of said pyramidal structure is closed by a generally planar base wall, said chamber comprising the interior volume of said pyramidal structure.

22. A radar antenna assembly as claimed in Claim 19 or Claim 20, wherein said chamber comprises a closed volume communicating with the open base of said pyramidal structure.

23. A radar system comprising pulsed signal generating means, transmitter antenna means, receiver antenna means, control means for controlling the operation of said pulsed signal generating means, analog-digital converter means for digitising signals received by said receiver antenna means, and data storage means for storing said digitised signals, wherein said transmitter antenna means and receiver antenna means

comprise at least one radar antenna assembly as claimed in any one of Claims 1 to 22.

24. A radar system as claimed in Claim 23, wherein said transmitter antenna means comprises at least one transmitter radar antenna assembly as claimed in any one of Claims 1 to 18, and said receiver antenna means comprises at least one receiver radar antenna assembly as claimed in any one of Claims 1 to 19.

25. A radar system as claimed in Claim 24, wherein said transmitter and receiver antenna assemblies are disposed so as to transilluminate a subject.

26. A radar system as claimed in Claim 24, wherein said transmitter and receiver antenna assemblies are disposed so as to be co-axially aligned on opposite sides of a subject.

27. A radar system as claimed in any one of Claims 24 to 26, wherein said transmitter and receiver antenna assemblies are connected to a closed sample chamber adapted to enclose a subject.

28. A radar system as claimed in Claim 24, wherein said transmitter and receiver antenna assemblies are disposed such that said receiver antenna assembly receives a signal transmitted by said transmitter antenna assembly and reflected from a subject.

29. A radar system as claimed in Claim 28, wherein said transmitter and receiver antenna assemblies are

arranged such that their longitudinal axes are substantially parallel to one another with their second ends facing in the same direction.

30. A radar system as claimed in Claim 28 or 29, wherein said system is adapted to be portable.

31. A radar system as claimed in Claim 28 or Claim 29, wherein said system is adapted to be carried by a land vehicle.

32. A radar system as claimed in Claim 28 or Claim 29, wherein said system is adapted to be carried by a water-borne vessel.

33. A radar system as claimed in Claim 28 or Claim 29, wherein said system is adapted to be carried by a submersible vehicle.

34. A radar system as claimed in Claim 28 or Claim 29, wherein said system is adapted to be carried by an airborne vehicle.

35. A radar system as claimed in Claim 28 or 29, wherein said system is adapted to be carried by a space vehicle.

36. A radar system as claimed in Claim 28 or Claim 29, wherein the position of said transmitter antenna assembly is fixed relative to said receiver antenna assembly.

37. A radar system as claimed in Claim 28 or Claim 29, wherein at least one of said transmitter antenna assembly and said second antenna assembly is adapted to be movable relative to a subject.

38. A radar system as claimed in Claim 28 or Claim 29 in which one of said transmitter and receiver antenna assemblies is adapted to be movable relative to the other.

39. A radar system as claimed in any one of Claims 28 to 38, including a plurality of transmitter antenna assemblies.

40. A radar system as claimed in any one of Claims 28 to 39, including a plurality of receiver antenna assemblies.

41. A radar system as claimed in any one of Claims 28 to 40, for use with close range subjects, in which said control means is adapted to control said pulsed signal generating means so as to generate pulses with a pulse repetition frequency of the order of 100 kHz.

42. A radar system as claimed in any one of Claims 28 to 41, for use with close range subjects, in which said control means is adapted to control said pulsed signal generating means so as to generate pulses with a pulse width in the range 0.01 to 0.1 nanoseconds.

43. A radar system as claimed in any one of Claims 28 to 42, for use with close range subjects, adapted to capture data in a time range of 2 to 25 nanoseconds.

44. A radar system as claimed in any one of Claims 28 to 43, for use with close range subjects, adapted to transmit pulses with a minimum frequency in the range 100 to 1000 MHz and with a maximum frequency in the range 1000 to 10000 MHz.

45. A radar system as claimed in any one of Claims 28 to 40, for use with close to medium range subjects, in which said control means is adapted to control said pulsed signal generating means so as to generate pulses with a pulse repetition frequency of the order of 25 to 100 kHz.

46. A radar system as claimed in any one of Claims 28 to 40 or 45, for use with close to medium range subjects, in which said control means is adapted to control said pulsed signal generating means so as to generate pulses with a pulse width in the range 1 to 10 nanoseconds.

47. A radar system as claimed in any one of Claims 28 to 40, or 45 or 46, for use with close to medium range subjects, adapted to capture data in a time range of 2000 to 10000 nanoseconds.

48. A radar system as claimed in any one of Claims 28 to 40, or 45 to 47, for use with close to medium range subjects, adapted to transmit pulses with a minimum

frequency in the range 12.5 to 125 MHz and with a maximum frequency in the range 200 to 2000 MHz.

49. A radar system as claimed in any one of Claims 28 to 40, for use with long range subjects, in which said control means is adapted to control said pulsed signal generating means so as to generate pulses with a pulse repetition frequency of the order of 3.125 to 50 kHz.

50. A radar system as claimed in any one of Claims 28 to 40 or 49, for use with long range subjects, in which said control means is adapted to control said pulsed signal generating means so as to generate pulses with a pulse width in the range 10 to 25 nanoseconds.

51. A radar system as claimed in any one of Claims 28 to 40, or 49 or 50, for use with long range subjects, adapted to capture data in a time range of 20000 to 250000 nanoseconds.

52. A radar system as claimed in any one of Claims 28 to 40, or 49 to 51, for use with long range subjects, adapted to transmit pulses with a minimum frequency in the range 1 to 12.5 MHz and with a maximum frequency in the range 12.5 to 200 MHz.

53. A radar system as claimed in any one of Claims 23 to 52, further including data processing means for processing said digitised signals.

54. A radar system as claimed in Claim 53, wherein said data processing means is adapted to process said

digitised signals for the purposes of at least one of imaging, measuring, mapping, detecting, identifying and typecasting said subject.

55. A method of typecasting a subject comprising the steps of:

irradiating the subject with a pulsed, broad band radar frequency signal transmitted by at least one transmitter antenna;

detecting a return signal following interaction of said transmitted signal with said subject, using at least one receiver antenna;

calculating an energy-frequency spectrum of said return signal; and

analysing said energy-frequency spectrum to obtain a characteristic energy-frequency signature of said subject.

56. A method as claimed in Claim 55, wherein said step of analysing said energy-frequency spectrum comprises performing a statistical analysis of said energy frequency spectrum.

57. A method as claimed in Claim 56, wherein said statistical analysis includes at least one of principal components analysis, maximum likelihood classification and multivariate classification.

58. A method as claimed in any one of Claims 55 to 57, wherein said step of analysing said energy-frequency spectrum comprises frequency classification using energy bins.

59. A method as claimed in any one of Claims 55 to 57, wherein said step of analysing said energy-frequency spectrum comprises energy classification using frequency bins.

60. A method of identifying an unknown subject comprising the steps of:

obtaining an energy-frequency signature of said subject using the method of any one of Claims 55 to 59; and

comparing said energy-frequency signature of the unknown subject to a database of energy-frequency signatures of known subjects previously obtained using the method of any one of Claims 55 to 59.

61. A method as claimed in any one of Claims 55 to 60, implemented using a radar system as claimed in Claim 53 or 54.

62. A radar system as claimed in Claim 53 or 54, wherein said data processing means is adapted to perform the method of any of Claims 55 to 60.